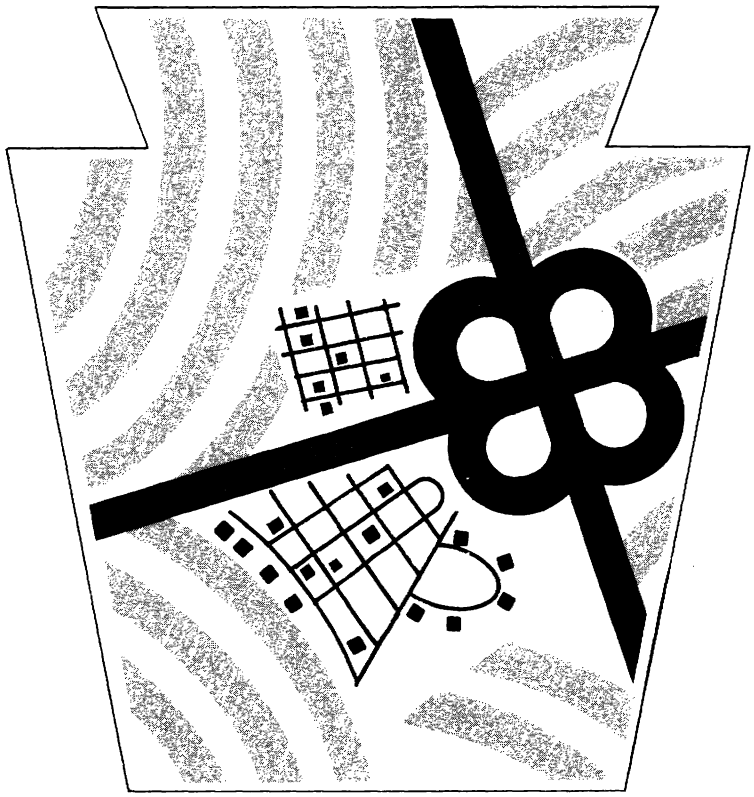

Economic and Population Growth in Smaller Central Place Areas of Pennsylvania

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ECONOMIC AND POPULATION GROWTH IN SMALLER PLACE AREAS OF PENNSYLVANIA. By R. Gar Forsht and J. Dean Jansma. Economic Research Service, U.S. Department of Agriculture, in cooperation with Pennsylvania State University, College of Agriculture, Agricultural Experiment Station. Agricultural Economic Report No. 310.

ABSTRACT

This study examines regional economic growth and development in Pennsylvania, with major emphasis on rural areas. The overall results indicate that many of the smaller rural areas in Pennsylvania are viable economic entities. The findings generally support the theory of balanced economic growth.

The rate of population growth from 1960 to 1970 was used to examine the economic activity of central place areas. A central place area consists of a central place (borough or city) plus its complementary or hinterland area. The results obtained, using multiple regression analysis, indicate that the percentage of workers employed in manufacturing durable goods (such as furniture, machinery, and metal products) and manufacturing nondurable goods (such as food, apparel, rubber, and plastic products) industries was highly correlated with the rate of an area's population growth. It was also found that the higher rates of population growth occurred in the smaller rural areas, which tended to attract the low-wage, nondurable goods industries. The economic activity of the areas oriented to the natural resource based industries of agriculture and mining were also examined. The agricultural areas were found to be scattered through the State; population was growing in these areas. Conversely, mining areas were concentrated in the northeast and west-central parts of the State; these areas were losing population.

Key Words: Regional growth, economic growth, economic development, economic activity, natural resources, multiple regression, urban areas, rural areas.

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SUMMARY

The lack of economic activity in many urban and rural areas is a major problem throughout the United States. Although many economists suggest that the larger areas have the best chance for reaching or sustaining acceptable levels of economic activity, this study indicates that smaller rural areas also have good potential.

The purpose of this study was to determine the association between selected characteristics and economic activity of various sized central place areas in Pennsylvania. Economic activity was measured by the rate of population growth from 1960 to 1970. This study attempted to meld the demographic and economic characteristics that apparently affect the interrelationship between population and income (jobs), and vice-versa. The results give some support to the proponents of balanced growth (moving the jobs to the workers) as opposed to unbalanced growth (moving the workers to the jobs) as a means of regional development to assist lagging rural and urban areas within the State.

Central place theory provided the framework for developing a hierarchy of small rural communities in Pennsylvania. The objective was to provide an alternative means of examining the economic activity of the State at smaller-than-county level. This study was based on all incorporated central places (boroughs and cities) with populations of 1,000 or more in 1960. Complementary or hinterland areas were delineated around each central place. The larger the center's population, the larger the designated hinterland.

Multiple regression analysis was used to measure economic activity, with major emphasis on the nonmetropolitan (rural) areas. A number of variables were found to be associated with the rate of population growth in the 1960's. The following conclusions were drawn from the study.

1. Manufacturing employment base and changes in manufacturing employment were important variables. The higher rates of growth occurred in areas that had a high percentage of workers in durable and nondurable goods manufacturing in 1960. Also, areas with higher rates of population growth were associated with higher rates of employment growth from 1960 to 1966 in the high-wage manufacturing durable goods industries.

2. For areas having centers with less than 25,000 population, the smaller the areas the higher the correlation between changes in manufacturing employment from 1960 to 1966 and the rate of growth in the 1960's.

3. Population growth tended to be higher in the 1960's in the smaller rural areas than in larger rural areas.

4. The areas oriented to agricultural employment tended to be scattered throughout the State and to have positive annual rates of growth from 1940 to 1970. In these areas, the higher rates of growth in the 1960's occurred in areas that had higher rates of growth in the 1940's and 1950's.

5. The mining oriented areas tended to be concentrated in the northeastern and west-central parts of the State, and to have negative annual rates of growth from 1940 to 1970. In these areas, the higher rates of growth in the 1960's occurred in areas that had higher rates of growth in the 1940's and lower rates in the 1950's.

6. The study indicates that many of the smaller rural areas in Pennsylvania are viable economic entities.

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INTRODUCTION

It has long been the tendency to judge a State's economy almost solely from the viewpoint of total production and consumption of goods, without reference to the specific location of economic activity. But a changing mix in economic activity tends to bring gradual shifts in employment opportunities within the industrial sectors and may even lead to the lack of employment opportunities in given areas. Economic growth and development are important not only geographically but also in terms of social justice. Thus, there is increasing pressure on Federal and State governments to assist lagging urban and rural areas.

In this report, Pennsylvania's population is considered a regional economy, spread out in space and forming a system of economic entities. The distribution of population refers to the spatial organization of an economy, or the configuration of the components of a social economic system. Changes in the State's total population bring stresses and strains in the structural and spatial distribution of the population. This report examines these changes through a statistical study of central place areas (boroughs or cities plus their hinterland areas) in Pennsylvania. In this way, the State's economic activity can be measured more effectively than by the traditional approach, i.e., by examining individual counties.

In 1790, agriculture was the predominant source of income and employment in Pennsylvania. Most people lived on farms or in small villages. Over the years, the State changed to an urban-industrial entity. By World War I, Pennsylvania had become an important industrial region because of the abundant supply of coal and the steel-making centers in the eastern and western parts.

A marked decrease in the rate of population growth in Pennsylvania began in the 1930's. This decrease was accompanied by a high level of unemployment, a heavy burden of relief payments, and the exodus of young people. In recent decades,

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Pennsylvania's economy has been strongly influenced by various U.S. economic trends relating to agriculture, coal mining, and rail transportation (39). 2/ Development of more efficient machinery, improved seeds, better fertilizers, and other changes have increased the individual farmer's productivity. As a result, agricultural employment continues to decline.

Coal mining employment has declined sharply in many areas of Pennsylvania. Rapid mechanization of mining operations has reduced the need for workers in relation to output. In some areas, coal mining has not been economically feasible. Also, there has been a consumer shift from coal to other fuels and minerals.

The once important railroad repair and junction points have suffered a severe economic decline. Railroads are no longer the country's dominant means of transportation. The dominance of diesels has further reduced the number of railroad workers.

With the decline of employment in agriculture, mining, and railroads, which have historically formed the economic backbone of rural and small-town life in Pennsylvania, rural residents have migrated to the larger cities and surrounding areas. The number of urban places of 2,500 inhabitants or more increased from 3 in 1790 to 448 in 1970. Urban population increased from 10.2 to 71.5 percent of the State's total.

Objectives

The study's objective was to measure the economic activity of the various sized central place areas in Pennsylvania. (A central place is a center of 1,000 or more population. The central place, plus its complementary or hinterland area, is called a "central place area" in this report). Specific objectives were to: (1) review regional economic growth and development literature, and develop a hierarchy of central place areas; (2) report the association between the selected independent variables and the rate of population growth from 1960 to 1970 for the central place areas; and (3) report the relationship between selected independent variables and the economic activity of central place areas oriented to natural resource based industries.

Concepts of Regional Growth

Within the framework of regional economic growth and development (9), the specific conceptual issues examined are: (1) balanced versus unbalanced growth; (2) the role of natural resources in regional economic growth and development; and (3) central place theory.

Balanced Versus Unbalanced Growth

A major theoretical dispute has centered around balanced or unbalanced growth

2/ Underscored numbers in parentheses refer to items in the Bibliography.

as a means of regional development. The proponents of rural development favor balanced growth; many urban economists tend to favor unbalanced growth. The policy alternatives can be summarized as: "Should government policy move the job to the worker (balanced growth) or the worker to the job (unbalanced growth)?"

Proponents of balanced growth believe it is more equitable to invest public funds in areas with the greatest need. Several reasons have been given to support this concept. First, a depressed area should be helped on moralistic grounds (13). Since the people of these areas cannot help themselves, the public sector should assist them. Second, economic activity should be increased within the depressed areas so that people will have employment and needed public services (17, 42). This implies it is more equitable to improve the quality of living in areas where people choose to live, rather than encourage them to migrate to other areas. Third, rural development advocates contend that cities of 5,000-25,000 population are large enough to attract new industries, provided they have the essential infrastructural facilities and resources (11, 17).

Weaver (42), a former Secretary of the Department of Housing and Urban Development, indicates that balanced growth is needed to meet three essential freedoms: (1) choice of one's place of residence; (2) adequate education and employment; and (3) availability of cultural, recreational, and other amenities. Weaver also points out that, unless the rural areas provide employment opportunities and adequate public facilities and services, they will not hold their populations. Jansma and Day (17) contend that balanced growth provides a more equitable distribution of benefits and costs to improve the quality of living for all people. They suggest this should be done even at some compromising of the Nation's efficiency and accumulation of wealth.

Proponents of balanced growth or dispersed investment point out several advantages over unbalanced growth. They contend it is less costly to live in small and medium-sized cities than in the larger metropolitan areas and that there is less congestion, noise, and air and water pollution in rural areas (29, 41).

Public investment probably would not provide the maximum potential for regional economic growth and development (3). A second limitation, it has been argued, is that the types of industries that locate in the smaller rural areas probably would not be the modern growth industries.

The proponents of unbalanced growth argue that public investment should be concentrated in larger urban centers. This approach attempts to stimulate further growth, attract outside capital, or encourage local product and production innovation, and ultimately spread economic growth to nearby smaller centers. Advocates of unbalanced growth or concentrated investment policy argue that the economies of agglomeration in relation to efficiency of size are prerequisites for growth and development. Hoover outlined three types of agglomeration economies:

(1) Large scale economies within a firm, resulting from the enlargement of the firm's scale of production at one point;

(2) Localization economies for all firms in all industries at a single point resulting from the enlargement of the total output of that industry at that location; and

(3) Urbanization economies for all firms in all industries at a single location, resulting from the enlargement of the total economic size (population, income, output, or wealth) of that location, for all industries taken together (16).

The first of these agglomeration economies is internal to the firm. The last two are external to the firm, and may give rise to externalities. The general opinion is that firms can more easily purchase the goods and services needed to produce their own products from other firms located in cities of 25,000 or more population. Thus, the intermediate-size or larger centers provided economies of agglomeration more readily than the smaller centers.

The second argument in favor of unbalanced growth is that, in the long-run, the net demands for infrastructure (social and economic overhead capital such as schools, highways, and sewage systems) to support a given increase in economic activity are lowest in the very large centers. However, opinions differ in regard to the most efficient size of cities. Cameron (3) suggests the optimum size lies between 30,000 and 250,000 inhabitants, and that the infrastructural cost curves have the familar U-shaped distribution when plotted against the increasing size of the community. He found there was a significant upward thrust of the cost curve in communities of less than 5,000 and over 25,000 inhabitants. If Cameron's theory is correct, cities within this population range can increase their economic activity more efficiently than the small and very large cities. This disagrees with Thompson's (32, 33) and Hansen's (14) contentions that cities of a quarter of a million people are the minimum critical size for providing self-generating and viable economic growth.

The main idea behind unbalanced growth is that a city must reach a certain size before public investments will substantially increase regional economic growth and development. Size depends on the economies of agglomeration, and researchers differ in their opinions on size. The advocates of "growth centers," such as Fox (8) and Cameron (3), focus on cities of 25,000 to 250,000 inhabitants. The "megalopolists," such as Thompson and Hansen, contend that populations of at least 250,000 are needed for viable economic growth and development. In comparison, proponents of "rural development" contend that many centers with populations of 5,000 to 25,000 can provide economic growth and development (11, 17). However, the type of industries and the services found in rural areas are not necessarily the same as those found in larger cities.

The Economic Development Administration (39) stresses concentrated investment (unbalanced growth) in growth centers as the best means of increasing economic activity in a depressed area. The National Goals Research Staff (20) favors investment in growth centers in nonmetropolitan areas to bring about balanced growth. The National Goals Research Staff contends that growth centers will attract people who would otherwise settle in very large cities and thereby add to existing problems. On the whole, the term "growth centers" is not very clearly defined as it relates to balanced or unbalanced growth.

In summary, the advocates of balanced or unbalanced growth apparently fall into three groups: (1) rural development advocates, who favor a dispersed planning policy to achieve economic growth and development; (2) proponents of megalopolis, who favor concentrated planning; and (3) advocates of medium-sized growth centers, who tend to agree with the rural development advocates in

regard to infrastructural facilities essential to viable growth.

It is hypothesized that balanced growth would be better than unbalanced growth and development in Pennsylvania. This study provides some indication of the minimum size a center should be in order to foster economic growth.

Natural Resources and Economic Growth and Development

Perloff and Wingo point out that natural resource endowment is a changing concept, closely associated with the dynamics of economic growth and development (27). This is true because natural resource endowment is a function of consumer preferences, income distribution, and production technology, all of which change continuously over time. Zimmerman was probably the first to express the changing concept of the relationships of natural resources to economic growth and development:

> (Natural) resources are highly dynamic functional concepts; they are not, they become, they evolve out of the triune interaction of nature, man, and culture, in which nature (natural resources) sets the outer limits, but man and culture (education, training, income, and technology) are largely responsible for the portion of physical totality that is made available for human use. The command over energy, especially inanimate energy, is the key to resource availability. And, finally, the world is not "a bundle of hay" but a living growing complex of matter and energy, a process rather than a thing (44, pp. 814-815).

Perloff (25) says "the natural resources that matter" shift as a regional economy passes through three general periods of growth and development: (1) agricultural, (2) industrial (mining and manufacturing), and (3) tertiary or service periods. During the agricultural period, land is the essential natural resource. Specialization in agriculture provides the beginning of interregional trade, made possible by a network of markets and transportation systems.

The second, or industrial period, is characterized by a rapid increase in mining and manufacturing. Iron ore and coal are very important manufacturing ingredients, and the locations of iron ore, coal, and the market are the major determinants of regional growth. New production technologies permit the area to further diversify in the manufacture and distribution of products and thereby promote its economic growth.

The final period is reached when an area specializes in tertiary or services activities for internal and external use. During this period, the natural environmental or "amenity" resources of water, air, climate, and space are important in decisionmaking and regional economic growth (26).

Researchers do not entirely agree on the importance of natural resources on economic growth and development. Landsberg argues that "natural resources of land and its products, water, minerals, fuels, and the nonfuel minerals still are the indispensable physical stuff that provides the material basis of modern civilization (economic growth and development)" (18, p. 1). However, Schultz (30) contends that primary production--mining and especially agriculture--may be detrimental to economic growth. The question than arises, how do we recon-

cile these two contradictory ideas concerning the importance of natural resources on economic growth and development? Landsberg apparently looks at a region in the first period of growth when agriculture is the primary source of employment and income; the region's population is not qualified for adopting new technological changes to achieve further development. On the other hand, Schultz assumes that a region has reached the final period of growth and development when tertiary activities are the primary source of employment and income. Therefore, it appears that the importance of natural resources for economic growth depends on the stage of development of the region.

Perloff and Wingo, in speaking of regional economic growth and development in the United States, say "natural resources...need not enter directly into the processes of production, but only influence directly the location of market as well as of production" (27, p. 222). Perloff (25) and Barnett and Morse (1) contend it is time to restructure the concept of natural resources from strictly a commodity (land and mineral) orientation to a more general amenity (environmental) orientation, so that the concept will have the greatest possible relevance today and in the future.

Central Place Theory

Many small Pennsylvania towns are only a few miles apart; a smaller number of larger cities are located at wider intervals; and still more widely spaced are two large cities (Philadelphia and Pittsburgh). The various cities differ in their commercial functions, at least to the degree that the smaller towns offer only limited goods and services, midsize cities offer these same goods and services plus more specialized ones, and so on up the scale. This spacing of towns and cities and the functions they perform appear to relate to conditions that prevail at the time of settlement. Walter Christaller (4) developed his "central place theory" to explain this spatial distribution of cities over a given region.

Central place theory is characterized by the spatial arrangement of various sized central places and the functions they provide to their surrounding areas. A "central place" is a town or city that provides goods and services to an area larger than itself. In general, the larger the central place, the larger the market area served and the greater the specialization of the services offered. Furthermore, centers of lower order or size tend to "nest" within the fringe or market areas of centers of the next higher order. The lower order centers depend on the higher order centers for functions of greater complexity or for the specialized goods and services they themselves cannot provide. This nesting relationship of higher and lower order centers, plus their fringe areas, defines the "hierarchy of central place areas."

Christaller (4) was the first to bring a comprehensive view and concrete approach to the study of the structural and spatial distribution of a social system. Von Thunen (40) had studied the relationship of the location of the various types of agricultural pursuits relative to a population center, and Weber (43) had studied the location of industry relative to such factors as transportation, labor, and agglomeration. However, Christaller attempted to study an entire economic system comprised of spatially oriented cities and their surrounding areas. He assumed the task of synthesizing Von Thunen's and

Weber's theories into a coherent statement about human settlement in the geographical landscape.

August Losch (19) modified Christaller's central place theory regarding the arrangement and size of central places. Losch avoided Christaller's assumptions that there are a certain number of cities of each size, that they are evenly spaced, and that the hinterland regions for all cities of a given size have the same area and shape. Losch did assume a hierarchy of cities classifiable by size and area of hinterlands, but he did not presuppose a certain set of distances between central places. Rather, he examined each area to ascertain the actual distances and population sizes. Christaller's system is based on the expected, instead of the actual, location of central places. Losch's system is based on the actual location of central places. Since Losch's system does not necessarily exhibit the rigid geographical pattern proposed by Christaller's, it has been widely accepted.

In general, researchers use the complexity of functions performed, rather than total population of the centers, in determining a hierarchy of central places. However, previous researchers have found a significant relationship between complexity of functions and population of the central places. Therefore, this study uses central place population as the means of developing a hierarchy of central place areas in Pennsylvania.

DEVELOPMENT OF A HIERARCHY OF CENTRAL PLACE AREAS IN PENNSYLVANIA

The empirical verification of a hierarchy of central place areas in Pennsylvania was based on the pioneering work of Christaller (4) and Losch (19). The objective of developing a hierarchy was to provide an alternative means of analyzing the economic activity of the State for areas smaller than individual counties. There were three reasons for using this procedure: (1) most firms make location decisions with reference to specific communities; (2) economic growth tends to take place within a matrix of central place areas; and (3) the basic spatial relationships in a regional economy occur between a central place area and another (10). Moreover, the spatial relationship of central places provides a basis for planning subregional development.

Principal Data Sources

The principal data used in the report were population, socioeconomic measures, and employment, listed by minor civil divisions in Pennsylvania. 3/ The accuracy of the report findings was improved by using the spatial, industrial, and occupational information for minor civil divisions. Because the data were not available in a single publication at the minor civil level, several sources were used.

The principal data sources were the State's County Labor Force Reports (24) and and the U. S. Census Tracts (34). Both publications provided detailed data on population, occupational employment, and industrial employment (table 1).

County Labor Force Reports provided data on the labor force in minor civil divisions for 51 of the 67 counties of Pennsylvania for 1960. These data were not available from other published sources. The labor force characteristics for the other 16 counties were obtained from the Census Tracts. The term "census tracts" refers to small geographical areas comparable to the minor civil division of the County Labor Force Reports.

Several other published and unpublished sources provided additional information. Pennsylvania's Estimates of Personal Income for 1963 (23) provided data by place of residence for all of Pennsylvania's minor civil divisions. Estimates of personal income were based on the 1960 population. Median school years completed and median income of families came from unpublished data of the U.S. Bureau of the Census, which also provided population data (36, 37).

The State's County Industry Reports (22) provided data at the minor civil division level for the entire State. A standard road map of Pennsylvania was used to calculate the distance between central places.

3/ A minor civil division is a city, borough, or township.

Table 1--Classification of data used in the analysis of central place areas Pennsylvania 1/

Classification of data
Population, income, and distance
Population, 1940 2/
Population, 1950 2/
Population, 1960 3/
Population, 1970 4/
Median school years completed 5/
Median income of families (dollars) 5/
Average per capita income, 1963 (dollars) 6/
Population density (persons per square mile) 7/
Distance (miles to nearest SMSA center) 8/
Occupational employment structure 3/
Professional, technical, and kindred workers (professional)
Managers, officials, and proprietors, including farmers and farm managers (managers)
Clerical and kindred workers (clerical)
Sales workers (sales)
Craftsmen, foremen, and kindred workers (craftsmen)
Operatives and kindred workers (operatives)
Private household and service workers (household and service)
Laborers, including farm laborers and farm foremen (laborers)
Industrial employment structure 3/
Agriculture, forestry, and fisheries (agriculture)
Mining
Construction
Manufacturing
Durable goods
Furniture, fixtures, lumber and wood products (furniture and lumber)
Primary and fabricated metal products (metals)
Machinery, including electrical equipment (machinery)
Transportation equipment
Stone, clay, and glass and instrument products (other durable goods)
Nondurable goods
Food and kindred products (food)
Textile and apparel products (textile and apparel)
Printing, publishing, and allied products (printing)

See footnotes at end of table. (Continued)

Table 1--Classification of data used in the analysis of central place areas, Pennsylvania 1/ (Continued)

Classification of data
Ordnance, tobacco, chemicals, petroleum, rubber and plastic, leather, paper, and miscellaneous manufactures (Other nondurable goods)
Transportation and public utilities
Wholesale and retail trade
Finance, real estate, insurance, and services (services) 3/

1/ The categories in parentheses are the simplified terms selected for use in the tables and text, where appropriate. See (6) for SIC numbers.
2/ (36), Final Report PC(1)-40A, table 7, pp. 21-31.
3/ (24), Special Release IFC; and (34) Final Report PHC(1).
4/ (37), Preliminary Report; PC(2)-40A.
5/ (35), Special Table PH-3.
6/ (23), Tables 1-67, pp. 8-115.
7/ (22)
8/ Standard Metropolitan Statistical Area (SMSA) is a county or group of contiguous counties which contain at least one city or centers of 50,000 inhabitants or more, or two contiguous cities with a combined population of at least 50,000, the smaller of which must have at least 15,000 inhabitants.

Manufacturing employment was classified into durable goods and nondurable goods industries. Durable goods industries are classified as furniture and fixtures (SIC 25), lumber and wood products (SIC 24), primary metals (SIC 33), fabricated metal products (SIC 34), machinery (SIC 35), electrical machinery (SIC 36), transportation equipment (SIC 37), stone, clay, and glass products (SIC 32), and instruments (SIC 38). Nondurable goods industries are classified as food products (SIC 20), textile (SIC 22), apparel products (SIC 23), paper (SIC 26), printing and publishing products (SIC 27), ordnance (SIC 19), tobacco manufactures (SIC 21), chemical products (SIC 28), petroleum products (SIC 29), rubber and plastic products (SIC 30), leather products (SIC 31), and miscellaneous manufacturers (SIC 39).

Procedure for Developing a Hierarchy of Central Place Areas

Pennsylvania's population was considered as a system of central places, or a hierarchy of central places, together with their complementary areas. The study was based on all incorporated central places (boroughs or cities) of 1,000 population or more in 1960, grouped into size classes (table 2). Central place areas were delineated around central places of 1,000 population and over to include all cities, boroughs, and townships with over half of their area within the radii shown in table 3. Radii circles were not drawn around the two largest central places (class 8), Philadelphia and Pittsburgh. For

these two places, the complementary area used was the Standard Metropolitan Statistical Area (SMSA) or the total county area, in order to facilitate collecting and handling of data. Very little accuracy was believed lost by using this method. Moreover, if a given radius had been used for Philadelphia, the complementary area would have encompassed part of New Jersey, which was not in the study area.

Table 2--Population and number of central places, by class sizes, Pennsylvania, 1960

Class no.	Population of central places	Central places
	Class size	Number
1	1,000- 2,499	63
2	2,500- 4,999	38
3	5,000- 9,999	32
4	10,000- 24,999	27
5	25,000- 49,999	6
6	50,000- 99,999	6
7	100,000- 499,999	3
8	500,000-over	2

Table 3--Radius delineated around central places, by class sizes, Pennsylvania, 1960

Class no.	Population of central place	Radius of complementary area
	Class size	Miles
1-5	1,000- 49,999	5
6	50,000- 99,999	10
7	100,000- 499,999	15
8	500,000-over	SMSA counties 1/

1/ For Philadelphia, the SMSA encompasses the Pennsylvania counties of Philadelphia, Bucks, Chester, Delaware, and Montgomery. For Pittsburgh, the SMSA encompasses the counties of Allegheny, Beaver, Washington, and Westmoreland.

In selecting the radii, it was assumed that the larger the class size, the larger the hinterland area. A 15-mile radius was used for class 7 and a 10-mile radius for class 6. A 5-mile radius was used for classes 1 through 5 to avoid problems that might arise because of varying sizes of townships. Also, with today's transportation network, a difference of several miles between home and work is relatively unimportant in many small rural areas. However, this may not be true in some larger urban areas.

Initially, circles were drawn around all class 7 central places. All contiguous cities and townships with over half of their area in the given circle were included in the hinterland or complementary area. Moreover, all cities and boroughs within the complementary townships were included, even though they may have been beyond the given radius from the central place. Thus, for each central place area there was one central place plus its complementary area. The above procedure was used to delineate all central place areas. 4/ All areas were mutually exclusive.

In 1960, the two largest central place areas of Philadelphia and Pittsburgh (class 8) accounted for 53 percent of the total State population. 5/ The 17 central place areas in classes 5-8 accounted for about 77 percent of the total. Conversely, the 160 central place areas in classes 1-4 accounted for only about 16 percent of the total State population. Class 0 central place areas (below 1,000 population) were not included in this study. They accounted for less than 8 percent of the State's total population. 6/

The average rate of population growth from 1960 to 1970 by class size of central place areas is also shown in table 4. A comparison of population changes by various size central place areas shows classes 6-8 had larger positive increases than classes 1-4. Class 5 central place areas had the only average negative population change in the 1960's.

4/ The minor civil divisions (towns, cities, and townships) used to delineate the various central place areas by class size are given in the Appendix of: R. Gar Forsht, "Measurement of Economic Activity of the Central Place Areas in Pennsylvania, 1960-70" (unpublished Doctor of Philosophy Thesis, The Pennsylvania State University, University Park, Pa., 1972).

5/ The ranking of central place areas by population coincided closely with ranking by employment. This similarity was indicated by the highly significant Spearman rank correlation coefficient, 0.9839**, between the two rankings. This is significant at the 1 percent level of probability.

6/ For the spatial distribution of central place areas by hierarchial class size, see Forsht, R. Gar, op. cit.

Table 4--Population distribution and percentage change in total population, by class size of central place areas, Pennsylvania, 1960 and 1970

Class no.	1960 population		1970 population 1/		Percentage change in population 1960-70
	Total	Share of total	Total	Share of total	
	Number	Percent	Number	Percent	Percent
0 2/	821,972	7.26	845,544	7.25	2.87
1	294,901	2.61	301,728	2.59	2.32
2	303,847	2.68	309,246	2.65	1.78
3	461,696	4.08	467,822	4.01	1.33
4	746,132	6.59	753,043	6.45	0.93
5	369,544	3.27	352,562	3.02	4.60
6	1,144,495	10.11	1,210.557	10.37	5.77
7	1,179,821	10.42	1,215,559	10.42	3.03
8	5,996,958	52.98	6,213,504	53.24	3.61
Total (State)	11,319,366	100.00	11,669,565	100.00	3.09

1/ Preliminary 1970 population data were used because the final population data were not available at the time of the original study.

2/ Class 0 was comprised of all central places with less than 1,000 inhabitants and townships lying outside the central place areas of classes 1-8 in 1960.

CHARACTERISTICS ASSOCIATED WITH THE RATE OF POPULATION GROWTH

This section examines the relationship between the selected independent variables and the rate of population growth of the central place areas in Pennsylvania from 1960 to 1970. During this period, 97 of the 177 areas had increasing rates of population growth; 80 had decreasing rates of growth (table 5). A chi square test on the areas that gained and those that lost population in the 1960's indicated there was no difference in the proportion of areas in different classes that gained (or lost) population.

Table 5--Direction and average rate of population growth, by class size of central place areas, Pennsylvania 1960-70

Direction and rate of population growth	Class size of central place area								Total or average
	1	2	3	4	5	6	7	8	
	Number								Total
Direction:									
Gained	38	20	18	14	1	4	2	1	99
Lost	25	18	14	13	5	2	1	1	79
Total	63	38	32	27	6	6	3	2	177
	Percent								Average
Rate:									
Gained	11.1	12.3	7.4	10.8	1.9	10.4	6.0	6.6	4.5
Lost	-7.9	-7.5	-7.6	-10.1	-5.5	-6.6	-2.1	-0.9	-1.4
Average	2.3	1.8	1.3	0.9	-4.6	-5.8	3.0	3.6	3.1

The average rate of population change for those areas that gained or lost population in the 1960's is also shown in table 5. Among those areas which gained population in the 1960's, the smaller rural areas (classes 1-4) tended to have the higher rates while the larger urban areas (classes 5-8) had smaller rates of population growth. The same general relationship was found for those areas which lost population in the 1960's. For example, the smaller areas had larger negative rates of population change while the larger urban areas had smaller negative rates of growth. Although those data show the general direction and magnitude of population growth and decline from 1960 to 1970, they do not show the relationship between population growth or decline with other variables.

The identification of the characteristics associated with the rate of growth should provide valuable information for determining where an increase in economic growth and development is needed. 7/ It should also provide basic information for planning subregional development.

Least squares estimation procedures were used to estimate parameters of the following statistical model,

$$Y_t = a + b_1 X1_t + b_2 X_2 + \ldots + b_k X_k t + E_t$$

where Y is the dependent variable, X_i is the i-th of K independent variables ($i = 1, 2, 3, \ldots, K$), E is a random distribution with mean equal to zero and with variance uncorrelated with all X_i and with successive values of itself, and $t = 1, 2, 3, \ldots t$ is the subscript indicating the number of central place areas.

Multiple Regression Analysis

A stepwise multiple regression model was applied to determine which characteristics were associated with the dependent variable--percentage change in total population (rate of growth) during the 1960's. The dependent variable was regressed on the level of population, rates of population growth, levels of income and education, and occupation and industrial employment. The list of independent variables included in the multiple regression analysis were:

X_1 = Median School Years Completed, 1960. Duncan and Reiss (5) found that as median school years completed increased, the rate of population growth increased. They felt that the differences in the educational level among growing and declining cities was a function of the differences in the occupational and industrial composition of these cities. A positive coefficient was expected.

X_2 = Median Income of Families, 1960. A positive relationship was expected between population growth and median income of families, as shown by Duncan and Reiss (5).

X_3 = Average Per Capita Personal Income, 1963. As with median income, a positive relationship between average per capita income and the rate of population growth was expected.

X_4 = Log of Total Central Place Area Population, 1960. Conventional wisdom suggests that the larger the population of a given area, the more likely that

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7/ Although the rate of employment growth from 1960 to 1970 might have been a better measure of economic activity, employment statistics for 1960 were only available at the minor civil division level. Moreover, the rank correlation coefficient between the central place area ranking by population and by employment in 1960 was 0.9820**. Thus, it was felt that the rate of population growth from 1960 to 1970 would be a good measure of economic activity.

area's economic activity will increase. Conversely, the smaller the total population the less likely the area will attract new economic activity. Thus, a positive coefficient was expected.

X_5 = Log of Distance to Nearest SMSA Central City, in Miles. Previous research at The Pennsylvania State University has shown that employment growth at the county level was not related to close proximity to SMSA's (12). Another study has shown that the greater the distance between SMSA's, the greater the rate of population growth of the SMSA's (2). However, the literature search failed to yield any studies designed to determine the effect of distance to SMSA centers on the rate of population growth of cities or communities in rural areas. This study is expected to show that central place areas nearer the SMSA will have higher rates of population growth. Thus, a negative coefficient was expected.

X_6 = Percentage Change in Total Central Place Area Population, 1940-50. A positive coefficient was expected, for Bogue and Harris (2) found that population growth in the SMSA's in one decade leads to population growth in later decades.

X_7 = Percentage Change in Total Central Place Area Population, 1950-60. As with variable X_6, it was expected that population increases in 1950-60 would lead to population increases in 1960-70.

X_8 = Percentage Employed as Professional Workers, 1960. A study by Duncan and Reiss (5) on population growth of cities with more than 10,000 population indicated that population growth increased as the percentage of professional workers increased. 8/ Thus, a positive coefficient was expected.

X_9 = Percentage Employed as Managers, 1960. The percentage of workers employed as managers has been shown to have a direct effect on population growth (5). A positive coefficient was expected.

X_{10} = Percentage Employed as Clerical Workers, 1960. The percentage of workers employed in the clerical sector was expected to be directly related to the percentage of professional workers. A positive coefficient was expected.

X_{11} = Percentage Employed as Sales Workers, 1960. It has been indicated by a previous study that the percentage employed as sales workers had a direct effect on population growth (18). The sign of the regression coefficient was expected to be positive.

X_{12} = Percentage Employed as Craftsmen, 1960. The greater the percentages of workers employed as craftsmen, the lower the expected rate of population growth. This hypothesis was based on the Duncan and Reiss (5), results, which found a slightly higher proportion of craftsmen in declining places than in growing places. A negative coefficient was expected.

X_{13} = Percentage Employed as Operatives, 1960. The greater the percentage of workers employed as operatives, the lower the expected growth rate of population (5). A negative coefficient was expected.

8/ Duncan and Reiss (5) found that the rapidly growing places of 10,000 or more population had a higher percentage of workers employed in white-collar occupations. Conversely, declining places of 10,000 or more population had a higher percentage of workers employed in blue collar occupations.

X_{14} = Percentage Employed as Household and Service Workers, 1960. Other researchers have reported that the larger the percentage of the labor force employed as household and service workers, the lower the rate of population growth (5). A negative coefficient was expected.

X_{15} = Percentage Employed as Laborers, 1960. A negative coefficient was expected, since a previous study showed that the larger the percentage of workers employed as laborers, the lower the rate of population growth (5).

X_{16} = Percentage Employed in Agriculture, 1960. Conventional wisdom suggests a negative relationship between the percentage of workers employed in agriculture and the rate of growth. However, Smith (31) found that the counties in Pennsylvania oriented to agriculture had positive rates of employment growth. Although agricultural employment in general has trended downward, there has been a slower rate of decline over the past several decades. The majority of agricultural workers have settled on the more fertile lands of the State. Moreover, industries tend to locate in these areas. Population growth is also more likely in areas with low population density such as the agricultural areas. Thus, a positive coefficient was expected.

X_{17} = Percentage Employed in Mining, 1960. The greater the percentage of workers in mining, the lower the expected rate of population growth. Areas with a large proportion of the labor force in the mining sector are likely to be among the more depressed areas. The expected sign of the regression coefficient was negative.

X_{18} = Percentage Employed in Construction, 1960. It was hypothesized that those areas having a large percentage of workers in the construction sector would also have a high population growth rate because construction activity implies economic growth. A positive coefficient was expected.

X_{19} = Percentage Employed in Manufacturing Durable Goods, 1960. Bogue and Harris (2) and Duncan and Reiss (5) found that, for cities of 10,000 or more population, the higher the proportion of workers employed in all manufacturing activities, the lower the rate of population growth. In another study, Smith (31) found a mixture of positive and negative employment growth rates for Pennsylvania counties oriented to durable goods employment in 1956-66. This study seems to favor the hypothesis that the higher the percentage of workers employed in durable goods industries in 1960, the higher the rate of population growth in 1960-70. No studies were available for cities in classes 1-3 (10,000 or less population). A positive regression coefficient was expected for this characteristic.

X_{20} = Percentage Employed in Manufacturing Nondurable Goods, 1960. Although Bogue and Harris (2) and Duncan and Reiss (5) found a negative relationship between the percentage of workers employed in total manufacturing activities and the rate of population growth, Smith (31) found that the higher the proportion of workers in nondurable goods manufacturing the higher, in general, the rate of employment growth at the county level. Thus, a positive coefficient was expected.

X_{21} = Percentage Employed in Transportation and Public Utilities, 1960. Pennsylvania's economy in the years past depended heavily on the railroad

industry. Modernization of the railroads caused a serious decrease in railroad employment, and areas with a high percentage of employment in the transportation industries were expected to have a low rate of population growth. Although areas with a high percentage of employment in public utilities are the larger urban cities, which would be expected to have higher growth rates, there are only 17 urban areas in the State whereas there are 160 smaller sized rural areas. Therefore a negative correlation was expected.

X_{22} = Percentage Employed in Wholesale and Retail Trade, 1960. The larger the percentage of workers in wholesale and retail trades the larger the expected population growth (5). A positive correlation was expected.

X_{23} = Percentage Employed in Services (Finance, Insurance, Services, and Real Estate), 1960. It was hypothesized that the percentage employed in the service sector would be directly related to population growth. The service sector consisted of industries closely related to population growth. A positive coefficient was expected.

X_{24} = Percentage Employed in Government, 1960. A positive coefficient was expected since the larger the percentage of people employed in government, the larger the amounts of Federal assistance to provide these services. Smith (31) found that a large percentage of the State's total employment growth was directly related to increased government employment. Duncan and Reiss (5) also found that those cities with increasing populations had a larger percentage of people employed in the government sector than did the cities with declining populations. Thus, a positive correlation was expected.

X_{25} = Density of Central Place (Population Per Square Mile), 1960. Bogue and Harris (2) found that the greater the population density of the SMSA central city the lower the rate of population growth. In addition, the tendency for population growth is greater for cities with a lower population density. Thus, a negative coefficient was expected.

Rate of Population Growth in All Areas

Table 6 shows the results of a multiple regression analysis, using the above list of independent variables to estimate the rate of population growth from 1960 to 1970 for the 177 areas in classes 1-8. An R^2 of 0.60 in table 6 indicates that 60 percent of the variation in the dependent variable was associated with the independent variables. The percentage change in total population in the 1940's had the highest correlation with the rate of population growth in the 1960's, as shown by the size of the beta coefficient. One reason for this finding was that the average rate of growth for all areas in the 1940's, rather than in the 1950's, more nearly corresponded to population growth in the 1960's. For example, the average rate of population growth of all areas was 6.7 percent in the 1940's, 8.5 percent in the 1950's, and 3.1 percent in the 1960's. Since the average central place area's rate of growth, in general, was higher in the 1950's than in the 1940's, there was a higher relationship between population growth in the 1960's and 1940's. However, there is no apparent economic reason for this finding and it was probably a spurious type of correlation. Since there does not appear to be any causative effect of this relationship, it will not be discussed any more throughout the report.

The log of total population was also highly correlated. The negative sign on the log of total population was not expected. One explanation is that the smaller sized areas have smaller population bases, and a relatively small increase in total population causes a large increase in the rate of population growth. Moreover, the higher rates of positive population occurred in the smaller rural areas (see table 5).

The negative coefficient on the log of distance to the nearest SMSA central city indicated that the smaller rural areas located nearer larger urban areas had the higher rates of growth. This finding may be attributed, in part, to people commuting from rural areas outside the urban areas (classes 5-8) to work in larger urban areas. A recent Economic Research Service (ERS) study reported that about 70 percent of the rural population lives in communities that contain 25,000 or more urban population or 10,000 nonfarm salary or wage jobs, or from which 10 percent of workers commute to such counties (38). The ERS study also pointed out that only one county in Pennsylvania was considered to be a noncommuter county. The combined negative coefficient on the logs of total population and distance suggest that the smaller rural areas with the higher rate of population growth were located nearer the SMSA central cities of the larger urban areas.

Two of the occupational variables were significantly associated with the dependent variable. The percentages of workers employed as laborers and as operatives were highly correlated with the rate of population growth in the 1960's. Both had negative coefficients, as anticipated. This indicates that areas with a higher proportion of employment in blue-collar occupations tend to have lower rates of population growth.

Of the nine industrial variables used in the analysis, three had significant coefficients. 9/ As evidenced by the beta coefficients and the t-tests of significance, relatively high rates of employment in industries manufacturing both durable and nondurable goods are conducive to increasing population growth.

Rate of Population Growth in the Small Rural Areas

Since the preceding regression analysis showed that rates of employment in both durable and nondurable goods manufacturing were highly correlated with the rate of population growth in the 1960's, several additional manufacturing employment variables were substituted and the rural areas within discrete size categories were analyzed. This was made possible because another study, completed at Pennsylvania State University, measured changes in specific manufacturing employment from 1960 to 1966 in the 160 areas in classes 1-4. 10/ Thus, by

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9/ The combined employment in durable goods and nondurable goods industries equals the total manufacturing employment. By looking at the separate association of manufacturing durable goods and nondurable goods employment with the dependent variable, a more detailed picture of the total manufacturing employment structure is obtained.

10/ This study provided the manufacturing data by Two-Digit Industries for the 160 central place areas in classes 1-4 (11).

Table 6--Regression results on percentage change in total population, 177 central place areas, classes 1-8, Pennsylvania, 1960-70

Variable	Variable number	Regression coefficient	Standard error	Beta coefficient
Log total population, 1960	X_4	1/-7.50355	2.06565	-0.31
Log distance	X_5	1/-4.74761	1.43106	-0.24
% change total population 1940-50	X_6	1/-0.56346	0.07001	0.59
Employment:				
% operatives, 1960	X_{13}	2/-0.34069	0.14153	-0.21
% laborers, 1960	X_{15}	1/-0.89163	0.25969	-0.22
% agriculture, 1960	X_{16}	2/ 0.34589	0.17376	0.13
% construction, 1960	X_{18}	2/ 0.81556	0.40466	0.12
% manufacturing durables, 1960	X_{19}	1/ 0.23613	0.08521	0.21
% manufacturing nondurables, 1960	X_{20}	1/ 0.38380	0.09785	0.30
% government, 1960	X_{24}	2/ 0.42669	0.17645	0.19
Constant		38.60		
R^2		1/ 0.60		

1/ Significant at 1% level of probability.
2/ Significant at 5% level of probability.

incorporating the changes in manufacturing employment for the 160 areas in this report, a more concise regression analysis was possible. In addition to measuring specific changes in manufacturing employment from 1960 to 1966, shares of employment in durable goods and nondurable goods industries from 1961 to 1966 from new plants moving into each area were also substituted. The changes in manufacturing employment from 1960 to 1966 and new manufacturing employment from 1961 to 1966 were recorded by place of employment.

Except for employment in manufacturing durable goods (X_{19}) and nondurable goods (X_{20}), all of the independent variables used in the original regression analysis were used in the following analyses. The additional variables were:

X_{26} = Change in Employment in the Furniture and Fixtures (SIC 25), and Lumber and Wood Products (SIC 24) Industries, 1960-66. 11/

X_{27} = Change in Employment in the Metals (SIC 33 and 34) Industries, 1960-66.

X_{28} = Change in Employment in the Machinery (SIC 35 and 36) Industries, 1960-66.

X_{29} = Change in Employment in the Transportation Equipment (SIC 37) Industries, 1960-66.

X_{30} = Change in Employment in Other Durable Goods (Stone, Clay, Glass, and Instruments) (SIC 32 and 38) Industries, 1960-66.

X_{31} = Change in Employment in Food and Kindred Products (SIC 20) Industries, 1960-66.

X_{32} = Change in Employment in Textile and Apparel Products (SIC 22 and 23) Industries, 1960-66.

X_{33} = Change in Employment in the Printing and Publishing (SIC 27) Industries, 1960-66.

X_{34} = Change in Employment in Other Nondurable Goods (Ordnance, Tobacco, Paper, Chemicals, Petroleum, Rubber and Plastic, Leather, and Miscellaneous Products (SIC 19, 21, 26, 28, 29, 30, 31, and 39, respectively) Industries, 1960-66.

X_{35} = New Employment in Durable Goods Industries, 1961-66.

X_{36} = New Employment in Nondurable Goods Industries, 1961-66.

X_{37} = Percentage Change in Employment in the Durable Goods Industries, 1960-66.

X_{38} = Percentage Change in Employment in the Nondurable Goods Industries, 1960-66.

Using the above independent variables, multiple regression analyses were used to measure the rate of population growth in the 1960's for each of three discrete class sizes. 12/ First, the 160 rural areas in classes 1 through 4

11/ It was hypothesized that positive changes in manufacturing employment from 1960 to 1966 and new manufacturing employment from 1961 to 1966 would be associated with increased rates of population growth for each of the variables X_{26} to X_{38}.

12/ The following analyses differ from the preceding analysis in that they use changes in manufacturing employment from 1960 to 1966 and new manufacturing employment from 1961 to 1966; the previous analysis used the level of manufacturing employment in 1960.

(centers of 1,000 to 24,999 population), were analyzed to determine the rate of growth. In the second analysis, 101 rural areas in classes 1 and 2 (centers of 1,000 to 4,999 population) were considered. In the final analysis, 63 rural areas in class 1 (centers of 1,000 to 2,499 population) were considered. 13/ The specific analysis on various combinations of class sizes should provide a more meaningful and informative regression analysis on the rate of population growth in the 1960's for specific class sizes.

Rate of Population Growth for Area Classes 1-4

Table 7 gives the results of the regression analysis to estimate the parameters of the data for area classes 1-4. The value of R^2 indicates that 62 percent of the variation in the dependent variables was associated with the independent variables. The percentage change in total population in the 1940's had the highest correlation with the dependent variable, as shown by the relative size of its beta coefficient.

The log of total population in 1960 was also highly correlated with the rate of population growth in the 1960's. Although the sign was the opposite of that hypothesized, it agrees with the result in table 6. As total population increased, the rate of growth decreased, indicating that within the area classes 1-4, the smaller sized rural areas tended to have the higher rates of population growth. This result is also shown in table 5.

Two nonmanufacturing industrial sector variables were highly correlated with the rate of growth. The percentage of workers employed in mining had a negative correlation; the percentage of workers employed in the government sector had a positive correlation. These results suggest that areas with the highest rate of population growth tend to have a high proportion of people engaged in government related work and low proportion employed in mining.

The percentage of workers employed as craftsmen had a positive correlation with the area's rate of growth; laborers had a negative correlation. Perhaps the most surprising result was the negative sign for median school years completed (table 7). This indicates that as median school years completed increased, the rate of growth decreased. Several reasons are hypothesized for this finding. First, the results of the log of total population indicate that on the average the smaller areas grew more rapidly than the larger areas. Further, it was found that the smaller the area's population, the lower the level of schooling. For example, the average median school years completed in 1960 for area classes 1 through 4 were 9.85, 9.97, 10.28, and 10.40, respectively. It was also hypothesized that the small rural areas having higher rates of population growth were attracting the low-wage industries, which do not require higher levels of education. This hypothesis is supported by Gingrich (12) who found that the low-wage manufacturing industries accounted for the

13/ Classes 2, 3, and 4 were not analyzed separately because the number of areas in each class was too small to provide the necessary degrees of freedom for a regression analysis.

largest share of employment growth in the rural counties of Pennsylvania between 1961 and 1965. Finally, the small areas may have had a larger proportion of their population in the older age group; these older people generally have less schooling than younger people.

Only one of the variables measuring changes in manufacturing employment from 1960 to 1966 was significantly associated with the dependent variable. This was the rate of change in manufacturing durable goods employment, which had a negative correlation with rate of population growth. As shown in table 7, the greater the percentage increase in employment in the durable goods industries, the lower the rates of growth for the 160 areas in classes 1-4. One explanation for this result is that the durable goods manufacturing industries pay median to high wages and the work is suitable for workers with low levels of education. 14/

Rate of Population Growth for Area Classes 1 and 2

Table 8 shows the regression results on the percentage change in total population from 1960 to 1970 for area classes 1 and 2. The R^2 is 0.61. The log of total population had a significant negative regression coefficient, indicating that the smaller the population in area classes 1 and 2, the larger the rate of growth in the 1960's. Much of the previous literature on economic growth suggests that these small areas cannot survive on their own; they do not have the essential infrastructure and technical know-how for generating viable economic growth. However, the results in table 8 are consistent with the results of previous analyses in this study. One reason offered for the survival of these small areas is suggested by the sign on the regression and beta coefficient associated with variable X_1. Median school years completed (X_1) had a negative correlation with the rate of growth. As the median school years completed increased, the rate of growth in the 1960's decreased. This suggests that employment opportunities in these areas are suitable for people with lower levels of education. 15/

Changes in machinery employment from 1960 to 1966 had a significant positive regression coefficient indicating a direct association with rate of growth, but the small size of the regression coefficient indicates a relatively weak relationship. The change in machinery employment may be explained by the high positive change in employment from 1960 to 1966 for areas in classes 1 and 2 (11).

Three of the industrial sector variables were highly correlated with the rate of population growth in the 1960's. The most highly correlated was the percentage of workers employed in mining. The larger the percentage of workers in the mining sector, the lower the rate of total population growth. There was

14/ The negative, although insignificant, sign on average per capita income tends to substantiate this line of reasoning.

15/ The negative, although insignificant, sign on the average per capita income variable tends to support this line of reasoning.

also a negative relationship between the percentage employed in transportation and public utilities. However, the larger the percentage employed in government, the larger the rate of growth in the 1960's. The only significant occupational variable was the percentage of workers employed as laborers, which had a negative correlation with area growth.

A comparison of area classes 1-4 and classes 1-2 (tables 7 and 8) shows that six of the eight independent variables are the same and have relatively the same size regression coefficients. Both analyses indicate that the higher rates of growth occurred in the smaller sized rural areas. Additionally, smaller sized rural areas with higher rates of growth tended to have low median school years completed.

Rate of Population Growth for Area Class 1

The preceding two regression analyses found that the smaller areas tended to have the most rapid rates of population growth in the 1960's. Some of the smaller areas also had the most rapid rates of population decline (table 5). Thus, a separate analysis on the 63 areas in class 1 was undertaken to further explore the above findings. The regression results (table 9) show an R^2 of 0.77. Rather surprisingly, the change in transportation equipment employment had the higher correlation with the rate of growth in the 1960's. Its negative regression coefficient will be discussed later.

Both the log of total population and the log of distance to the nearest SMSA central city had highly significant negative regression coefficients. These results suggest that the smaller sized areas within class 1 areas tended to have the higher rate of population growth from 1960 to 1970. In addition, the smaller rural areas (within class 1 areas) with the higher rates of population growth tended to be located nearer the larger urban areas. One explanation for the smaller sized rural areas located nearer the urban areas having higher rates of population growth is that some of the industries once located in the urban areas moved to the smaller rural areas outside the urban areas. Another explanation is that more and more people tend to move away from the larger urban areas but continue to work there. This suggests that small rural communities in class 1, located outside the larger urban areas, serve as bedroom communities for people working in the urban areas (38).

The percentage change in total population from 1940 to 1950 had a highly positive correlation with the rate of growth in the 1960's. However, the beta coefficient was approximately half the size it was in the two previous analyses, indicating that its relative importance decreased when only data for class 1 areas are analyzed. 16/

16/ Although the rate of growth in the 1950's was not significant, its regression coefficient was positive, indicating that areas having population growth in the 1950's also had population growth in the 1960's. This suggests there has been a steady increase in population growth over the past 3 decades for the class 1 areas.

Table 7--Regression results on percentage change in total population, 160 central place areas, classes 1-4, Pennsylvania 1960-70

Variable	Variable number	Regression coefficient	Standard error	Beta coefficient
Median school years, 1960..	X_1	1/-3.15760	0.91858	-0.22
Log total population, 1960.	X_4	1/-12.72305	2.57731	-0.31
% change total population, 1940-50	X_6	1/ 0.60163	0.07121	0.62
Employment:				
% craftsmen, 1960	X_{12}	2/ 0.57817	0.26887	0.13
% laborers, 1960	X_{15}	2/ -0.62067	0.24611	-0.14
% mining, 1960.....	X_{17}	1/ -0.44277	0.11859	-0.23
% government, 1960.....	X_{24}	2/ 0.39544	0.15307	0.17
% change in manufacturing durables, 1960-66.....	X_{37}	1/ -1.00683	0.3275	-0.17
Constant.....		24.63		
R^2		1/ 0.62		

1/ Significant at 1% level of probability.
2/ Significant at 5% level of probability.

The percentage of workers employed in wholesale and retail trades was the only nonmanufacturing variable to enter the analysis; it had a highly negative correlation with population growth. This negative association may be due in part to underutilization of employees in wholesale and retail trades in areas with high growth rates. Among the significant manufacturing variables, change in furniture and lumber employment from 1960 to 1966 had a highly positive correlation with population growth. This may be due in part to the lack of lumber products in the larger areas and the low wages paid by industries attracted to the smaller areas (7, 11). 17/

17/ Although the variable of median school years completed was not significant in this analysis, its negative coefficient indicated that the class 1 areas having the largest increase in rate of growth were associated with a low level of education.

Table 8--Regression results on percentage change in total population, 101 central place areas, classes 1 and 2, Pennsylvania, 1960-70

Variable	Variable number	Regression coefficient	Standard error	Beta coefficient
Median school years, 1960....	X_1	2/-2.59308	1.21659	-0.16
Log total population, 1960...	X_4	2/-10.63666	4.97577	-0.15
% change in total population, 1940-50.....	X_6	1/ 0.77836	0.10334	0.59
Employment: % laborers, 1960.....	X_{15}	2/-0.64014	0.29387	-0.15
% mining, 1960.....	X_{17}	1/-0.40675	0.14725	-0.22
% transportation & public utilities, 1960.....	X_{21}	2/-0.45195	0.18259	-0.16
% government, 1960.....	X_{24}	2/ 0.39564	0.19540	0.14
Change in machinery industry, 1960-66.....	X_{28}	2/ 0.00880	0.00428	0.13
Constant		73.20		
R^2		1/ 0.61		

1/ Significant at 1% level of probability.
2/ Significant at 5% level of probability.

The transportation equipment industry had a highly negative correlation with the rate of population growth. As the rate of transportation equipment employed from 1960 to 1966 increased, the rate of growth of the 63 class 1 areas decreased. Transportation equipment industries in general pay high wages and require highly trained people (in a technical sense, although they may not be highly educated) who are not likely to be found in large numbers in small rural areas. 18/

18/ This tends to be substantiated by the negative coefficient found on average per capita income.

Table 9--Regression results on percentage change in total population, 63 central place areas, class 1, Pennsylvania, 1960-70

Variable	Variable number	Regression coefficient	Standard error	Beta coefficient
Log total population, 1960	X_4	1/-24.07530	5.76255	-0.31
Log distance	X_5	1/-24.64558	3.99942	-0.23
% change total population, 1940-50	X_6	1/ 0.39227	0.11509	0.28
Employment:				
% managers, 1960	X_9	1/ 1.09808	0.28488	0.34
% craftsmen, 1960	X_{12}	1/ 1.31708	0.32537	0.32
% laborers, 1960	X_{15}	1/ -0.85994	0.30379	-0.23
% wholesale and retail trade, 1960	X_{22}	1/ -0.81276	0.27041	-0.23
Change in furniture and lumber industries, 1960-66	X_{26}	1/ -0.03505	0.01092	0.24
Change in transportation equipment, 1960-66	X_{29}	1/ -0.10157	0.02153	-0.36
Change in manufacturing durables, 1960-66	X_{37}	2/ -1.27452	0.50231	-0.18
Change in manufacturing nondurables, 1960-66	X_{38}	2/ 0.37174	0.17747	0.15
Constant		96.60		
R^2		1/ 0.77		

1/ Significant at 1% level of probability.
2/ Significant at 5% level of probability.

The percentage changes in durable and nondurable goods manufacturing from 1960 to 1966 were highly correlated with the rate of population growth in the 1960's. The percentage in durable goods employment had a negative coefficient; the nondurable goods employment had a positive coefficient. These results tend to agree with the findings in a previous study of the Pennsylvania economy by

Smith (31), who found that the counties oriented toward nondurable goods industries tended to have positive employment growth rates from 1956 to 1966; counties oriented toward the durable goods industries tended to have negative employment growth rates.

Three occupational variables were highly correlated with the rate of growth of the 63 areas in class 1. The employment rates for managers and craftsmen had positive regression coefficients; the employment rate for laborers had a negative coefficient. These results indicate that, as the percentage of workers employed in white collar occupations increased, the rate of population growth increased. One explanation for the positive regression coefficient for craftsmen (blue-collar workers) is that their employment has an impact more closely related to employment as managers than as laborers. The percentage of workers employed as managers and craftsmen were the second and third most significantly correlated variables in the analysis, as shown by their beta coefficients.

The results in this analysis on the 63 areas in class 1 indicate the faster growing areas were the smaller sized rural areas. The higher rates of population growth occurred in rural areas located nearer the larger urban areas. Further, there was a tendency for the growing areas to attract the low wage-paying nondurable manufacturing industries but to lose the higher wage-paying durable manufacturing industries. 19/

Summary of the Rate of Population Growth

The regression analyses designed to examine the relationship between the selected independent variables and the percentage change in total population in the 1960's indicated that, within each size category analyzed, the higher rates of population growth occurred in the smaller sized rural areas. Although the regression analysis did not indicate that some of the smaller areas also had the most rapid rates of population decline in the 1960's, this relationship is shown in table 5. Moreover, within the class 1 areas, the higher rates of population growth occurred in those rural areas located nearer the larger urban areas. The industrial employment variables were associated in each analysis with the rate of growth in the 1960's. The most consistently correlated nonmanufacturing variables were employment in mining and government activities.

Occupational employment variables were also associated with the variation in the rate of growth. The most consistently correlated occupational variable was the percentage of workers employed as laborers. The percentage of workers employed as craftsmen was also highly associated with population growth.

The analyses also indicated that smaller areas having higher rates of population growth were associated with low levels of median school years completed which tended to attract the low-wage manufacturing industries. Conversely, the high-wage industries were less likely to locate in the small rural areas.

19/ These results are supported by the negative coefficients found on median school years completed and average per capita income.

ANALYSIS OF AREAS ORIENTED TO THE NATURAL RESOURCE BASED INDUSTRIES

The preceding section analyzed the characteristics associated with the rate of population growth, with major emphasis on rural areas with centers under 25,000 population. Proceeding from these findings and using the stepwise multiple regression technique, the following analyses will focus on the central place areas oriented toward the natural resource based industries of agriculture or mining.

The criteria for determining the orientation of the central place areas in terms of the agriculture, mining, manufacturing, or tertiary sectors were determined by the percentage distribution at the State level. The central place areas were oriented to the sector that exhibited the largest positive deviations from the State percentage distribution. Only the central place areas oriented to agriculture or mining in 1960 are reported in this section. The 37 areas oriented to agriculture are mainly in classes 1 and 2 and tend to be scattered throughout the State. The 32 areas oriented to mining are distributed over a wider range of classes, and are concentrated in the northeast and west-central parts of the State.

This section consists of two subsections. The first subsection examines the relationship between the annual rate of population growth from 1940 to 1970 and the orientation to agriculture or mining. The second subsection reports the results of the multiple regression analyses used to measure the characteristics associated with the rate of population growth from 1960 to 1970.

Annual Rates of Population Growth

Annual rates of population growth were determined by measuring the percentage changes in total population occuring between 1940 and 1970 for each of the 69 central place areas oriented to the natural resource based industries. First, the decennial rates of growth for the 1940's, 1950's and 1960's were summed for each of the 69 agricultural and mining areas. Next, the sum of the rates of growth for each area was divided by 30 to yield the annual rate of population growth. Although this procedure assumes linearity to the derived annual rate of growth, it was felt that the use of the three decennial rates of growth, rather than the data for 1940 and 1970, only dampens the cyclical fluctuations and gives a better estimate of the annual rates of growth.

Table 10 gives the annual rates of growth from 1940 to 1970 for the 37 areas oriented to agriculture. The Loretto area (class 1) had the largest positive annual rate of growth (2.43 percent). The Forest City area (class 2) had the largest negative annual rate of growth (-1.25 percent). Twenty-seven of the agricultural areas had positive rates of growth and 10 areas had negative

Table 10--Central place areas oriented to agriculture, 1960, and class sizes and annual rates of population growth, Pennsylvania, 1940-70

Central place	Class size	1940-70 average annual population growth rate
	Number	Percent
Loretto	1	2.43
Mansfield	2	1.93
East Berlin	1	1.62
Greencastle	2	1.59
Lancaster	2	1.57
Saegerstown	1	1.47
Centre Hall	1	1.34
Mercer	2	1.21
New Mildford	1	1.20
Shinglehouse	1	1.19
Middleburg	1	1.07
Stewardstown	1	1.07
Cambridge Springs	1	0.81
Mifflinburg	1	0.81
Cochranton	1	0.78
Martinsburg	1	0.70
Mercersburg	1	0.62
Troy	1	0.54
Linesville	1	0.54
Towanda	2	0.50
Wellsboro	2	0.43
Knox	1	0.22
Rockwood	1	0.19
Conneautville	1	0.16
Canton	1	0.15
Mifflin	1	0.14
Honesdale	3	0.08
Hyndman	1	0.06
Stoneboro	1	-0.05
Westfield	1	-0.16
Montrose	1	-0.28
Berlin	1	-0.33
Boswell	1	-0.34
Meyersdale	2	0.58
Galeton	1	-0.67
Reynoldsville	2	-1.04
Forest City	2	-1.27
Average for agriculturally oriented areas		0.53
Average for all areas		0.58

growth rates. 20/ The average annual rate of growth for the 37 agricultural areas was 0.53 percent, compared with the State average annual growth rate of 0.58 percent. Rates of growth for 17 agricultural areas exceeded the State average; rates for the other 20 areas were below the State average.

Table 11 gives the annual rates of growth from 1940 to 1970 for the 32 mining areas. The Ebensburg area (class 2) had the largest positive annual rate of growth (0.57 percent); the Shenandoah area (class 4) had the largest negative annual growth rate (-2.09 percent). The average annual rates of growth for the 32 mining areas was -0.91 percent, compared with the State average annual growth rate of 0.58 percent. 21/ Only two of the 32 mining areas had positive rates of growth and both of these had an annual rate of growth less than the State average. 22/

Tables 10 and 11 indicate a pattern of variation between the annual rates of growth and class sizes of the 69 areas. The areas oriented to agriculture tended to have relatively small populations, and positive annual growth rates not exceeding 2.00 percent. Conversely, the mining areas tended to fall in various population class sizes and have negative growth rates. 23/

Rate of Population Growth

Multiple regression analysis was used to relate the 25 independent variables listed on pages 15-18 to the dependent variable--rate of population growth from 1960 to 1970--in areas oriented to agriculture and mining. 24/ These results are compared below with the results obtained previously to determine the similarity and differences.

Agricultural Areas

Table 12 shows the multiple regression results on the rate of population growth for the agricultural areas in the 1960's. The R^2 of 0.62 indicates that 62

20/ Twenty-eight of the 37 agricultural areas had positive rates of growth from 1960 to 1970.

21/ Two of the 32 mining areas had positive rates of growth from 1960 to 1970.

22/ The 59 manufacturing and 49 tertiary oriented areas in this study had average annual rates of growth from 1940 to 1970 of 0.50% and 0.86% respectively.

23/ These results agree with Smith's (31) findings; he found that agriculture oriented counties tended to have relatively small employment bases and positive annual rates of growth, while the mining counties tended to have a mixed pattern of total employment base sizes and negative annual growth rates.

24/ The variables for manufacturing durable and nondurable goods, by place of residence in 1960, are used in this section. The variables measuring the changes in manufacturing employment from 1960 to 1966 were not used because the number of agricultural or mining areas (observations) was too small to provide the necessary degrees of freedom for a regression analysis.

Table 11--Central place areas oriented to mining, 1960, and class sizes and annual rates of population growth, Pennsylvania, 1940-70

Central place area	Class size	1940 - 70 average annual population growth rates
	Number	Percent
Ebensburg	2	0.57
Pine Grove	1	0.16
Smithport	1	-0.06
Eldred	1	-0.17
Bradford	4	-0.39
Patton	2	-0.50
Homer City	1	-0.60
Kane	3	-0.63
Tower City	1	-0.73
Phillipsburg	2	-0.76
East Brady	1	-0.78
Pottsville	5	-0.81
Wilkes-Barre/Scranton	7	-0.82
New Bethlehem	1	-0.82
Hooversville	1	-0.83
Hazleton	5	-0.86
Fairchange	1	-0.87
Freeland	3	-0.92
Point Marion	1	-0.99
Clymer	1	-1.02
Portage	2	-1.05
Rimersburg	1	-1.07
Barnesboro	3	-1.09
Houtsdale	1	-1.25
Tremont	1	-1.27
Ashland	3	-1.32
Central City	1	-1.39
Shamokin	4	-1.46
Mount Jewett	1	-1.60
Masontown	2	-1.66
Mount Carmel	4	-1.96
Shenandoah	4	-2.09
Average for mining oriented areas		-0.91
Average for all areas		0.58

percent of the variation in the dependent variable was associated with the independent variables. The rates of population growth in the 1940's and the 1950's were highly positively correlated with the rate of growth in the 1960's.

This indicates that the higher the rates of population growth in the 1940's and 1950's, the higher the rates of growth in the 1960's for those areas oriented to agriculture.

Median family income had a highly correlated negative coefficient. This indicates that the higher level of median family income was associated with lower rates of population growth in the 1960's. The percentage of workers in wholesale and retail trades was the only industrial variable associated with the dependent variable. As found previously, the areas with the higher rates of population growth tended to have a higher proportion of their workers employed in low-wage industries. Wholesale and retail trades tended to pay relatively low wages. Therefore, the positive coefficient on the wholesale and retail trade variable substantiates the negative sign on median family income.

Mining Areas

Table 13 shows the results of a regression analysis relating the previously specific independent variables to the rate of population growth in the 1960's for the 32 areas oriented to mining. The value of R^2 was 0.58. Although the rates of growth in the 1940's and 1950's were both significant, the regression sign was positive for the 1940's and negative for the 1950's. These results indicate that higher rates of growth in the 1940's and lower rates of growth in the 1950's were associated with higher rates of growth in the 1960's for the mining areas. The fluctuation in mining operations tend to be somewhat volatile, while agricultural activities tend to be more stable.

Table 12--Regression results on percentage change in total population, 37 central place areas oriented to agriculture, Pennsylvania, 1960-70

Variable	Variable number	Regression coefficient	Standard error	Beta coefficient
Median family income, 1960.....	X_2	1/-0.01295	0.00315	-0.52
% change in total population, 1940-50.....	X_6	1/ 0.83509	0.16131	0.63
% change total population, 1950-60	X_7	1/ 0.65002	0.17431	0.47
% employment in wholesale and retail trades, 1960	X_{22}	2/ 0.99587	0.43256	0.26
Constant.....		42.89		
R^2		1/ 0.62		

1/ Significant at 1% level of probability.
2/ Significant at 5% level of probability.

Table 13--Regression results on percentage change in total population, 32 central place areas oriented to mining, Pennsylvania, 1960-70

Variable	Variable number	Regression coefficient	Standard error	Beta coefficient
Log distance	X_5	1/-5.55855	2.03006	-0.36
% change total population, 1940-50	X_6	1/ 0.49777	0.15579	0.55
% change total population, 1950-60	X_7	1/-0.24380	0.06713	-0.61
Employment: % manufacturing durables, 1960	X_{19}	1/ 0.53784	0.15404	0.54
% government, 1960	X_{24}	1/ 1.72913	0.61960	0.39
Constant		-20.64		
R^2		1/ 0.58		

1/ Significant at 1% level of probability.

Two industrial variables had highly positive correlations with the rate of growth. These were the percentage of workers employed in manufacturing durable goods and in government industries. These findings agree with the results found in the previous analysis on all areas (see table 6). But since regression analysis on class 1-4 areas (centers of under 25,000 population) did not use the same manufacturing variables, direct comparison is not possible. 25/

Log of distance to the nearest SMSA center was highly correlated with the rate of growth in the 1960's. This indicates that the mining areas closer to the urban areas had the higher rates of population growth.

25/ A separate analysis on the rate of growth from 1960 to 1970 for classes 1 through 4 areas, using the level of manufacturing durable and nondurable goods employment in 1960 versus changes in manufacturing employment from 1960 to 1966, showed that employment rates for both durable and nondurable goods had highly positive correlations with the dependent variable.

Summary of Natural Resource Based Areas

Of the 69 central place areas oriented to the natural resource based industries in 1960, 37 were agricultural and 32 were mining areas. The annual rates of growth from 1940 to 1970 for the areas were examined. The analysis confirmed the results obtained by Smith (31) that annual rates of growth tended to be positive for agricultural areas and negative for mining areas.

The regression results on the rate of population growth in the 1960's for the agricultural and mining areas indicated that the rate of growth in the 1940's was the only variable with a consistently high correlation (positive) with the dependent variable. Conversely, the rate of growth in the 1950's had a highly positive correlation with the rate of growth in the 1960's for the agricultural areas and a negative relationship for the mining areas. This suggests a more stable rate of growth in agricultural than in mining areas from 1940 to 1970.

None of the occupational variables for either area was significantly correlated with the rate of growth in the 1960's. At least one industrial variable was highly associated with the rate of growth in each analysis. Wholesale and retail trades employment was correlated for agricultural areas, and durable goods and government were highly correlated for the mining areas.

Concluding Observations

The results of this study indicate that many of the smaller rural areas in Pennsylvania experienced relatively high levels of economic growth in the 1960's, and some small areas experienced relatively high levels of population decline. Moreover, the smaller rural areas with the higher rates of population growth tended to have a higher proportion of workers employed in durable and nondurable goods manufacturing in 1960. These results give credence to a balanced growth policy and to rural development in general.

The conceptual framework, hierarchy of central place areas, used in this study provides a base upon which to add new data and make additional analyses. This is especially true for formulating rural development policy alternatives in order to answer: (1) What causes industries to move into rural areas? (2) How will zoning guidelines affect future growth and development of rural areas? (3) What are the housing needs for rural areas? (4) What manpower programs are available for retraining people in rural areas? (5) What financial institutions are present in rural areas? (6) What are the tax incentives for private businesses to locate in rural areas? Research into these problems would provide more information for formulating a development program for rural areas.

Although the results of this study indicate that small rural areas can be viable economic entities, more research is needed to formulate a comprehensive regional economic growth and development policy that will assist areas that are losing population and employment. Such a policy is essential to have a more equitable allocation of resources and distribution of income, and to improve the quality of living within the various urban and rural areas of the Nation.

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